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the girders, directly as the amount of deflection into the depth of the metal.

The paper concludes by pointing out the important amount of this resistance, the operation of which has been hitherto unknown, and which in cast iron exceeds the tensile strength of the metal, and shows that comparisons of the strength of different forms of section, based on the existing theory, which assumes the resistance at the outer fibre to be constant and equal to the tensile strength of the metal, must be entirely fallacious.

The paper is accompanied by full details of all the experiments, and the measurements for determining the position of the neutral axis.

II. "On the Metallic and some other Oxides, in relation to Catalytic Phenomena." By the Rev. J. EYRE ASHBY. Communicated by the Rev. JOHN BARLOW, F.R.S. Received March 8, 1855.

I purpose to detail some experiments on the metallic (and a few other) oxides, made with a view to ascertain their powers to produce and maintain, catalytically, the combustion of various gases and vapours; and to annex such considerations as appear to be suggested by the facts. By catalysis I understand the operation of one body upon another, under favourable circumstances, whereby the second body is resolved into new chemical combinations, while the first (whatever may happen during the process) remains finally unchanged. This must be taken as not including explosion by percussion, in which the change takes place owing to the external application of dynamic force.

The apparatus for experimenting comprehends a variety of shallow capsules; wire-gauze, of iron, copper, and brass, of different degrees of fineness, cut into discs a little larger than the vessels on which they are to be superimposed; a spirit-lamp with large wick; a pair of pliers, and a few rings of wire to support the gauze, if necessary, while heating it in the spirit flame. The method of procedure is simple: the watch-glass, or capsule, is *nearly* filled with

the liquid whose vapour is to be tried; on a wire-gauze disc is spread the oxide whose powers as a catalyser are to be tested, and this being warmed (more or less) over the lamp, is set down upon the upper rim of the capsule. Sometimes it is necessary to heat a layer of the oxide in the middle of a small combustion-tube, and pass over it the gas, or mixture of gases.

I tried the following substances with pyroxylic spirit (hydrated oxide of methyl) and alcohol separately.

1. Co.O appeared to possess the power in some degree, but perhaps the specimen was in too dense agglomeration, which is not essentially reduced by trituration.

2. Co₂O₃ maintained the catalytic combustion very well.

3. Ag.O, reduced to metallic silver, which shows a strong tendency on gauze, and acts perfectly in the combustion-tube.

4. U₂O₃, HO became, at red heat, anhydrous mixture of UO and U₃O₄, showing strong tendency. A very pure specimen catalysed the vapour as it changed from yellow to green, after which it died away. Will not act below 570° (F.).

5. Sn.O; strong tendency.

6. Sn.O₂; slight tendency.

7. W.O₃ apparently produces the effect if placed while glowing, over alcohol, but gradually dies away, as if very slowly cooling.

8. Pb₃O₄ changed to Pb.O, and showed a strong tendency, but quickly faded and grew cold.

9. Cd.O, placed while very warm over pyroxylic spirit, burst into glow and catalysed, but always died off after the lapse of from half a minute to two or three minutes, and then became incapable.

10. Ca.O (on the gauze), no effect.

11. Si.O₂ exhibited a tendency.

12. Stourbridge clay; no effect.

13. Al₂O₃ appeared to have no effect in maintaining catalytic combustion on the gauze, but when made red-hot and quenched in absolute alcohol, it changed from pure white to a black substance and oxidized a portion of the alcohol. That this is not owing to carbon in the alcohol is evident, because the same change occurs when it is quenched in strong liquid ammonia. I suspect that it is a new oxide of aluminium.

14. Ni₂O₃, formed by heating carbonate of nickel nearly to red-

ness, failed; prepared from the common nitrate, it acted for a short time; reduced as an intensely black velvety substance from the purest nitrate, then warmed but not made red-hot, it glowed and catalysed with alcohol or ether. With pyroxylic spirit, it was left at the end of the operation of a greenish drab, which I suspect to be a mixture of Ni_2O_3 with $\text{Ni}.\text{O}$, although it may be Ni_2O_3 changed only in appearance, for when treated with nitric acid no nickel is dissolved.

15. Mn O_2 is changed at red heat into Mn_2O_3 , which, with alcohol, ether, and pyroxylic spirit, continues the slow combustion very steadily. A specimen of very pure Mn_2O_3 acted extremely well, as did also a portion of "euchrome" (a hydrated sesquioxide of manganese (impure) dug from the estate of Lord Audley), after being heated in the air to drive away the carbonaceous matter with which it was mingled. Mn_2O_3 will, if sufficient care be taken, catalyse the moist gas arising from a strong solution of ammonia.

16. Fe_2O_3 , when in the state of a light puffy powder, catalyses the vapour of ether, alcohol, and pyroxylic spirit, only requiring to be heated on the gauze before it is laid over the capsule. It is cheap, easily employed, and of invariable action. I have kept up the combustion for several hours on a surface of 120 square inches.

By means of a catalytic lamp in which the liquid employed is continually supplied from a reservoir and maintained at a constant level in the capsule, I have used 7 or 8 square inches continuously during thirty-six hours. This lamp I have occasionally used for laboratory purposes, where a gentle and equable heat was required for several hours.

Pursuing my experiments with the oxides of the metals, heated on wire gauze, I tried as many as I could procure or make, and by a tolerably wide induction I found that the *sesquioxides* have the strongest tendency to produce and maintain the catalytic glow, and do produce it in every case in which they are not decomposed by the amount of heat required to begin the operation.

When hydrated Fe_2O_3 is heated and placed over alcohol, its colour is deepened towards black, but not uniformly, and when cold the original colour returns. But if it be made red-hot and quenched in boiling alcohol out of contact with air, it is converted into hydrated Fe_3O_4 , and remains permanently a deep black magnetic powder, soluble in acids. A strong solution of ammonia may be substituted

for the alcohol with the same effect, but in this case some of the sesquioxide will remain unaltered and mixed with the black oxide. The alcohol or ammonia is correspondingly changed by oxidation derived from the oxygen which has been released from combination with the iron. If the hydrated Fe_3O_4 be heated in contact with air, it immediately (even when it has been kept for many months) becomes Fe_2O_3 by oxidation from the atmosphere, but if heated to redness *in vacuo*, it cools unchanged. [Can the black powder of alumina be Al_3O_4 , formed in a similar way?] The process of catalysation by Fe_2O_3 is thus evident; the heated sesquioxide loses a portion of oxygen to the alcohol and becomes Fe_3O_4 , which is instantly reconverted into Fe_2O_3 by receiving oxygen from the air, and this alternation is constantly going on in every portion of the glowing mass. It is not a mere *action de présence*, but alternate reduction and oxidation of the sesquioxide, producing a continuous oxidation of the alcohol.

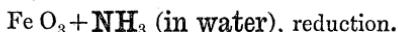
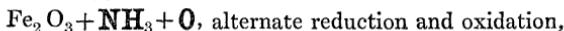
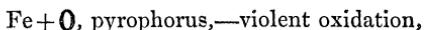
This suggests a consideration apparently adverse to the atomic hypothesis of Dr. Dalton. How can a single compound molecule Fe_2O_3 be changed by deoxidation into another compound molecule Fe_3O_4 , when, according to theory, there are in it but *two* combining proportions of iron, whereas the resultant contains *three*? and how (by deoxidation) can the resultant molecule contain *four* combining proportions of oxygen when the primary contained only *three*? We can indeed represent to the imagination that *three* molecules of the sesquioxide, acting as if they were one triple molecule, lose *one* combining proportion of oxygen, and are converted into *two* molecules of the black oxide; and conversely, that *two* molecules of the black oxide, acting as if they were *one* double molecule, combine with *one* atom of oxygen, and are converted into *three* atoms of sesquioxide. The only way to account for this, in accordance with the popular atomic theory, seems to be, to assume that the notation for these oxides is incorrect, and that

for Fe_2O_3 we should write Fe_6O_9 ,
and for Fe_3O_4 we should write Fe_6O_8 .

If the current notation be retained, and any law be admitted, in virtue of which three molecules of sesquioxide may suffer reduction as if they were only one molecule, and divide into two molecules of the magnetic oxide, we might conceive a peculiar structure in the

Fe_3O_4 , with a tendency to separate again into FeO , Fe_2O_3 ; that it is really in combination as Fe_3O_4 , but ready to yield to slight causes and become FeO , Fe_2O_3 . This would explain Mr. Mercer's experiment (quoted by Brande, I. 716, edition 1848) of the chemical union of a mechanical mixture of protoxide and peroxide of iron.

Perhaps the sesquioxides occupy a middle place in the scale of effects. Take the case of iron; we have



To show the last, add ammonia to a solution of FeO_3 , KO, and Fe_2O_3 will be precipitated.

A mixture of ten parts by weight of powdered chlorate of potassa with one part of Fe_2O_3 disengages oxygen with extreme facility and great economy of heat as compared with the oxides of copper and manganese; and it is the more convenient because n grains of the mixture will represent almost exactly n cubic inches of disengaged oxygen.

A state of mechanical division is not absolutely necessary for the catalysation of some inflammable vapours by Fe_2O_3 ; an old nail, entirely transmuted into rust, will perform the operation; and when we consider that in many cases of fermentation, decay and putrefaction, this oxide may be present, divided or aggregated, while heat is evolved, and inflammable gases and vapours are set free, we may hereafter be able to trace some instances of "spontaneous combustion" to the catalytic action of the sesquioxides of iron.

III. "Ocular Spectres and Structures as Mutual Exponents."

By JAMES JAGO, A.B. Cantab., M.B. Oxon., Physician to the Royal Cornwall Infirmary. Communicated by Professor STOKES, Sec. R.S. Received March 5, 1855.

The present communication is a revised and modified version of a paper bearing the same title, which was read on the 18th of January and 1st of February, and which was, by permission, withdrawn. The chief modification applies to the author's views respecting the struc-